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Patients with CLL have lower risk of death from COVID-19 in the omicron era.

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Abstract:
Previous studies have shown that patients with chronic lymphocytic leukemia (CLL) and corona virus disease 2019 (COVID-19) have high mortality rates. Infection with the omicron variant has been described as a milder disease course in the general population. However, the outcome for immunocompromised patients have not previously been reported. In a cohort of patients with CLL tested for severe adult respiratory syndrome coronavirus 2 (SARS-CoV-2) at hospital test sites in the time periods before and after dominance of the omicron variant, rates of hospitalizations and ICU-admissions declined significantly, whereas 30-day mortality remained as high as 23% in the period with dominance of the omicron sublineage BA.2 variant. However, for a larger population-based cohort of patients with CLL (including the hospital cohort), 30-day mortality was 2%. Thus, patients with CLL with close hospital contactss and in particular those above 70 years of age with one or more comorbidities should be considered for closer monitoring and pre-emptive antiviral therapy upon a positive SARS-CoV-2 test.

Conflict of interest: COI declared - see note

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Patients with CLL have lower risk of death from COVID-19 in the omicron era.

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Omicron COVID-19 in CLL

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Abstract

Previous studies have shown that patients with chronic lymphocytic leukemia (CLL) and corona virus disease 2019 (COVID-19) have high mortality rates. Infection with the omicron variant has been described as a milder disease course in the general population. However, the outcome for immunocompromised patients have not previously been reported. In a cohort of patients with CLL tested for severe adult respiratory syndrome coronavirus 2 (SARS-CoV-2) at hospital test sites in the time periods before and after dominance of the omicron variant, rates of hospitalizations and ICU-admissions declined significantly, whereas 30-day mortality remained as high as 23% in the period with dominance of the omicron sublineage BA.2 variant. However, for a larger population-based cohort of patients with CLL (including the hospital cohort), 30-day mortality was 2%. Thus, patients with CLL with close hospital contactss and in particular those above 70 years of age with one or more comorbidities should be considered for closer monitoring and pre-emptive antiviral therapy upon a positive SARS-CoV-2 test.

Key points

- In the era of the omicron variant of COVID-19, lower fatality rates in CLL are seen along with milder disease in the background population

- Patients with CLL who have hospital contact and test positive for SARS-CoV-2 should still be considered for pre-emptive therapy

Explanation of novelty

The omicron variant is reported to give milder disease in the general population; outcomes for immunocompromised patients have not been reported. Here, hospital- and population-based data on outcome in CLL upon infection with the omicron variant of SARS-CoV-2 warrants close monitoring and pre-emptive therapy upon a positive SARS-CoV-2 test for patients with CLL and frequent hospital contacts; other patients with CLL can expect a mild course of COVID-19.

Introduction

Patients with chronic lymphocytic leukemia (CLL) have increased morbidity and mortality following infection with severe adult respiratory syndrome coronavirus 2 (SARS-CoV-2) leading to coronavirus disease 2019 (COVID-19).[1,2] The immune dysfunction inherent to CLL itself and CLL treatment whether targeted or chemoimmunotherapy based, is considered the likely cause of increased susceptibility to severe COVID-19.[3] During the first and second pandemic wave, most CLL patients with COVID-19 developed severe disease and the 30-day mortality was 31-50% for those admitted, while one study indicates improved survival for patients with CLL upon COVID-19 later in the pandemic.[1,2,4] Further, patients with CLL demonstrated impaired vaccination response in terms of ability to produce neutralizing anti-SARS-CoV-2 antibodies, while the T-cell response was also impaired for part of the populations.[5-8] Data on outcome upon infection with SARS-CoV-2 B.1.1.529 (omicron) variant is warranted for immunocompromised patients in general and for patients with CLL in particular.[9] The first Danish omicron case was detected on 25th Nov 2021. The variant became dominant in Denmark by 17th Dec 2021, enabling high levels of break-through infections among vaccinated individuals.[10]

In Denmark, all patients diagnosed with a hematological malignancy were offered third and fourth booster vaccination against SARS-CoV-2 in August 2021 and January 2022, respectively. At the same time, a single dose of anti-SARS-CoV-2 monoclonal antibody (mAb) was recommended for immunocompromised patients testing positive for SARS-CoV-2 with sotrovimab being the most widely used mAb in Denmark, while the standard of care for immunocompromised patients admitted with moderate to severe COVID-19 was dexamethasone, low molecular weight heparin and remdesivir.[11,12] Remdesivir was widely used for hematological patients regardless of disease severity since approval mid-2020.[13,14] Sotrovimab retained its neutralizing activities against the omicron BA.1 sublineage, but recently, in vitro studies have shown reduced activity against the BA.2 sublineage.[15] [16]

Methods

Insights into potential variation in clinical outcome for immunocompromised patients upon infection with the omicron variant is limited. Here we investigated the rate of hospitalization, admission to intensive care unit (ICU) and mortality following infection with SARS-CoV-2 among patients with CLL in a Danish cohort with SARS-CoV-2 PCR test from electronic health records

(EHR) between March 2020 through January 2022 (EHR cohort). Additionally, we analyzed a cohort of patients registered with a diagnosis of CLL in the Danish CLL registry[17] for whom a positive SARS-CoV-2 PCR test was identified through the PERSIMUNE treatment database with microbiology data retrieved as previously described (population cohort).[18] As data on variants were missing for most patients, we grouped patients into four time periods based on the first positive SARS-CoV-2 PCR: Period 1: March 2020 - December 2020; Period 2: January 2021 - 25th November 2021 (first omicron case in Denmark); Period 3: 26th November 2021 - 31st December 2021; Period 4: 1st January 2022 - 28th January (omicron variant dominating from 17th December 2021 and sublineage BA.2 dominating from 1st January 2022). Data were retrieved from EHR covering a background population of approximately 2.8 million individuals.[19] We included all patients with a CLL diagnosis (ICD10 code DC91.1) and a positive PCR for SARS-CoV-2 within the EHR (EHR cohort). The population cohort initiates in September 2020, the time of introducing widespread testing outside the EHR. Patients with multiple positive PCR tests more than 12 weeks apart were considered as having reinfection. Baseline characteristics were stratified by time-period of first positive SARS-CoV-2 PCR test (Table 1). Primary outcomes were time to hospital admission, time to ICU admission and 30-day mortality. We followed patients from date of first positive PCR until event, death or date of last follow-up (22nd February 2022 and 15th March 2022 for the EHR and population cohort, respectively). The study was approved by the Ethics Committee and Data Protection Agency.

Results and Discussion

Until 28th January 2022, 151 patients with CLL had 153 COVID-19 infections confirmed with a positive PCR test for SARS-CoV-2 in the EHR system for Eastern Denmark (EHR cohort). Two reinfections were identified with positive PCR tests more than a year apart. Additionally, we identified 640 patients within the Danish CLL registry with a positive SARS-CoV-2 PCR test outside the EHR system (population cohort). No reinfections in terms of patients with positive PCR tests more than 12 weeks apart were identified within this cohort (patients within the EHR cohort were excluded from the population cohort). Stratified by period, 59, 40, 32, and 22 patients in the EHR cohort were first PCR positive in time periods 1 to 4, respectively. In the population cohort, 24, 66, 73 and 477 patients were first PCR positive in periods 1 to 4, respectively. There were no significant differences in baseline characteristics between the four periods, but patients in the EHR

cohort were significantly older compared with patients in the population cohort (*P* = .0052) even though the patients in the EHR cohort were also diagnosed with CLL significantly more recently ((Table 1; *P* = .024). At least 43 of 109 (39%) and 190 of 640 (30%) patients in the EHR and population cohort, respectively, had received CLL therapy prior to testing positive for SARS-CoV-2 (*P*=.054. For the EHR cohort, the rate of hospitalizations for patients with CLL testing positive for SARS-CoV-2 was significantly higher (>75%) during the second period compared with periods 3 (omicron emergence) and 4 (omicron dominance), where preemptive mAb were administered during hospital admissions for patients with CLL upon a positive SARS-CoV-2 PCR test (Figure 1A; P<.014). During period 3 and 4, mAb were administered at outpatient visits, which likely explains the lower 30-day admission rates (56-60% vs 83%). ICU admission rates were highest prior to emergence of omicron (12-12.5% vs 0-3%, Figure 1B), which may reflect impact of a third and fourth booster vaccine, improved care for patients with COVID-19 and differences in severity between SARS-CoV-2 variants.[11,12,20] The ICU admission rates were lower than previously reported in international cohorts of COVID-19 in CLL (26% to 37% for hospitalized patients).[1,2] This could be due to the full implementation of early treatment with mAb, almost universal treatment with remdesivir for hospitalized patients without renal failure and high vaccination rates and administration of up to 30 L/min oxygen outside the ICU in Denmark.

For the EHR cohort, 30-day overall survival (OS) was above 75% in all four periods (77-91%, Figure 1C). Despite representing a cohort with close hospital connection (EHR cohort), these survival rates are slightly better than the previously reported OS rates for COVID-19 in CLL during the first part of the pandemic (64-73%); although one study reported a higher OS rate of 89% for CLL patients testing positive for SARS-CoV-2 after 1st May 2020.[1,2] Five out of six fatal cases (including deaths after 30 days) in period 3 were infected with the delta variant (missing variant information for the last case, data not shown). The five patients who died within 30 days of a positive SARS-CoV-2 test in period 4 were aged above 71 years and all had comorbidities, e.g. dementia, other malignant diseases, diabetes, cardiac and pulmonary comorbidities. Four of the five fatal cases had confirmed omicron variant, while variant data were missing for the last case. Three of the five patients died from respiratory failure while two patients died at home without known cause of death. Two of the fatal cases received mAb and dexamethasone, one of them also remdesivir; the three remaining fatal cases did not receive COVID-19 specific treatment. To assess whether the

EHR cohort was biased towards patients with more severe COVID-19 and/or CLL disease, we next identified the population cohort who tested PCR positive for SARS-CoV-2 outside the EHR system. Only OS could be assessed for this population. Gradually improving 30-days survival rates were demonstrated from periods 2 through 4 (93.9%, 94.5% and 99.2%, respectively; no deaths were seen in time period 1 which started 16 September 2020 with mass testing; P<.002; pairwise log-rank, Figure 1D). When combining the two cohorts, 30-day OS rates gradually improved from periods 1 through 4 (88.0%, 89.6%, 93.3% and 98.2%, respectively) with a significantly higher OS in the omicron BA.2 period compared with periods 1-3 (*P*≤.0077; pairwise log-rank, Figure 1E).

Limitations apply to this study; the size of the EHR patient population was limited, patients with CLL testing positive for SARS-CoV-2 outside EHR test sites were only included in the population cohort. Thus, the improved outcome in the population cohort may reflect less severe CLL, less severe COVID-19 and/or less comorbidity.

Based on epidemiological data from South Africa,[21] the incidence of SARS-CoV-2 seems decoupled from the incidences of hospitalization and death upon emergence of the omicron variant, while previous vaccination seems to protect less against infection with the omicron variant of SARS-CoV-2.[22] This study indicate that omicron sublineage BA.2 pose a similar risk of fatal COVID-19 only for patients with impaired immune function due to CLL and a close hospital contact either due to CLL or COVID-19,[3,18] with an estimated 30-day OS rate of 77%. It should be emphasized that patients in the population cohort may also have been hospitalized, but no data on this were accessible. The overall population of patients with CLL seems to have a much milder course of COVID-19 during the era of the omicron variant, especially during BA.2 dominance, with a 30-day fatality rate of less than2%. Thus, patients above 70 with CLL and one or more comorbidities and hospital contact due to CLL or COVID-19 should be considered for closer monitoring and pre-emptive antiviral therapy upon a positive SARS-CoV-2 test.

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Authorship Contributions: SRO, CUN, CB and CdC developed the concept of the study, CB, CUN and CdC collected and curated data, CB performed statistical analyses, MH provided infectious disease and clinical perspectives and interpretation, CUN wrote the first draft of the paper, all authors contributed to and approved the final version

Conflicts of interest: CUN received research funding and/or consultancy fees outside this work from Abbvie, Janssen, AstraZeneca, Beigene, Roche, CSL Behring, Takeda and Octapharma. CB received consultancy fess outside of this work from AstraZeneca. The remaining authors declare no conflicts of interest.

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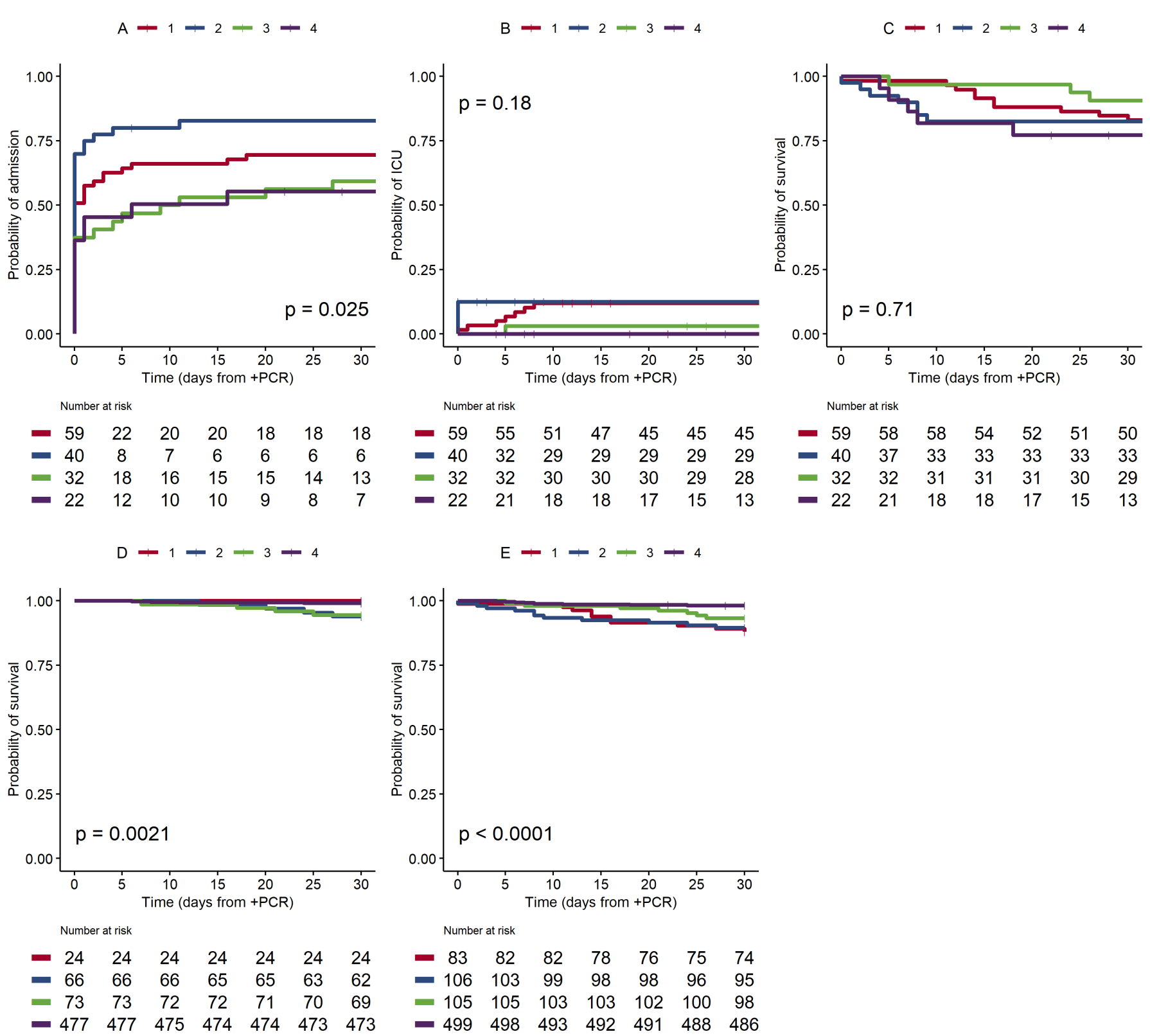
Table 1: Patient Characteristics, stratified on cohort (EHR or population) and period of COVID-19 positive test; Period 1: 12th March and 16th September 2020 for EHR and population cohorts, respectively, to 31st- December 2020; Period 2: January 2021 to 25th November 2021, Period 3: 26th November 2021 to December 2021; Period 4: January 2022 to 28th January 2022 and 7th March 2022 for EHR and population cohorts, respectively. Data on monoclonal antibodies against COVID-19 (mAb), remdesivir and dexamethasone treatment upon COVID-19 for the different time periods were only available for the EHR cohort. Continuous variables summarized with median and interquartile range (IQR) were tested using Kruskal-Wallis tests, whereas categorical variables summarized by count (percentage) were tested using chi-square tests for differences across all eight subgroups. *P*-values were calculated using Log-rank test.

Covariate		Period 1		Period 2		Period 3		Period 4			
		EHR (n= 59)	Population (n=24)	EHR (n=40)	Population (n=66)	EHR (n=32)	Population (n=73)	EHR (n=22)	Population (n=477)	Total (n=793)	*P*-value
Age at PCR	median [iqr]	71 [64.5, 80.5]	70.5 [54.2, 74.5]	77 [68.2, 82.0]	70 [62, 78]	74.5 [69.8, 83.0]	70 [63, 77]	76 [72.0, 80.5]	72 [64, 77]	72 [64, 78]	.0052
Sex	Female	27 (45.8)	7 (29.2)	17 (42.5)	24 (36.4)	12 (37.5)	29 (39.7)	9 (40.9)	181 (37.9)	306 (38.6)	
	Male	32 (54.2)	17 (70.8)	23 (57.5)	42 (63.6)	20 (62.5)	44 (60.3)	13 (59.1)	296 (62.1)	487 (61.4)	.91
CLL diagnosis	median [iqr]	2017 [2012, 2019]	2015 [2011.8, 2016]	2015 [2010, 2018]	2015 [2013, 2016]	2016 [2014, 2018]	2015 [2013, 2017]	2017 [2014, 2018]	2015 [2012, 2017]	2015 [2012, 2017]	.024
	missing	1	0	0	0	1	0	1	0	3	
Binet stage	A	34 (87.2)	20 (83.3)	22 (75.9)	57 (86.4)	21 (95.5)	69 (94.5)	14 (73.7)	402 (84.3)	639 (85.3)	
	B	3 (7.7)	2 (8.3)	6 (20.7)	7 (10.6)	1 (4.5)	4 (5.5)	3 (15.8)	65 (13.6)	91 (12.1)	
	C	2 (5.1)	2 (8.3)	1 (3.4)	2 (3.0)	0 (0.0)	0 (0.0)	2 (10.5)	10 (2.1)	19 (2.5)	.097
	missing	20	0	11	0	10	0	3	0	44	
IGHV status	Unmutated	8 (28.6)	6 (33.3)	9 (39.1)	18 (33.3)	6 (40.0)	19 (33.9)	3 (20.0)	105 (27.0)	174 (29.1)	
	Mutated	20 (71.4)	12 (66.7)	14 (60.9)	36 (66.7)	9 (60.0)	37 (66.1)	12 (80.0)	284 (73.0)	424 (70.9)	.70
	missing	31	6	17	12	17	17	7	88	195	
FISH status	Del13q	18 (64.3)	11 (64.7)	10 (43.5)	28 (54.9)	9 (50.0)	34 (61.8)	7 (46.7)	221 (61.6)	338 (59.7)	
	Normal	3 (10.7)	1 (5.9)	4 (17.4)	9 (17.6)	0 (0.0)	9 (16.4)	1 (6.7)	44 (12.3)	71 (12.5)	
	Tri12	4 (14.3)	3 (17.6)	3 (13.0)	6 (11.8)	5 (27.8)	9 (16.4)	3 (20.0)	53 (14.8)	86 (15.2)	
	Del11q	1 (3.6)	1 (5.9)	3 (13.0)	5 (9.8)	2 (11.1)	3 (5.5)	3 (20.0)	24 (6.7)	42 (7.4)	
	Del17p	2 (7.1)	1 (5.9)	3 (13.0)	3 (5.9)	2 (11.1)	0 (0.0)	1 (6.7)	17 (4.7)	29 (5.1)	.68
	missing	31	7	17	15	14	18	7	118	227	
Admission	Yes	41 (69.5)	NA	33 (82.5)	NA	19 (59.4)	NA	12 (54.5)	NA	105 (68.6)	
	No	18 (30.5)	NA	7 (17.5)	NA	13 (40.6)	NA	10 (45.5)	NA	48 (31.4)	.075
	missing	0	24	0	66	0	73	0	477	640	
ICU	Yes	7 (11.9)	NA	5 (12.5)	NA	1 (3.1)	NA	0 (0.0)	NA	13 (8.5)	
	No	52 (88.1)	NA	35 (87.5)	NA	31 (96.9)	NA	22 (100.0)	NA	140 (91.5)	.26
	missing	0	24	0	66	0	73	0	477	640	
Died	Yes	10 (16.9)	0 (0.0)	7 (17.5)	4 (6.1)	3 (9.4)	4 (5.5)	5 (22.7)	4 (0.8)	37 (4.7)	
	No	49 (83.1)	24 (100.0)	33 (82.5)	62 (93.9)	29 (90.6)	69 (94.5)	17 (77.3)	473 (99.2)	756 (95.3)	< .0001
Dexa-	Yes	11 (18.6)	NA	16 (40.0)	NA	9 (28.1)	NA	4 (18.2)	NA	40 (26.1)	

methasone	No	48 (81.4)	NA	24 (60.0)	NA	23 (71.9)	NA	18 (81.8)	NA	113 (73.9)	.090
	missing	0	24	0	66	0	73	0	477	640	
Remdesivir	Yes	12 (20.3)	NA	18 (45.0)	NA	8 (25.0)	NA	3 (13.6)	NA	41 (26.8)	
	No	47 (79.7)	NA	22 (55.0)	NA	24 (75.0)	NA	19 (86.4)	NA	112 (73.2)	.019
	missing	0	24	0	66	0	73	0	477	640	
mAb	Yes	0 (0.0)	NA	10 (25.0)	NA	12 (37.5)	NA	8 (36.4)	NA	30 (19.6)	
	No	59 (100.0)	NA	30 (75.0)	NA	20 (62.5)	NA	14 (63.6)	NA	123 (80.4)	< .0001
	missing	0	24	0	66	0	73	0	477	640	

Fig 1: Kaplan-Meier curves for (A) admission to hospital, (B) admission to intensive care unit (ICU), (C) overall survival (OS) for the EHR cohort; (D) OS for the population cohort and (E) OS for the combined cohort. Data are stratified for the following time periods: Period 1: 12th March and 16th September 2020 for EHR and population cohorts, respectively, to December 2020; Period 2: January 2021 to 25th November 2021, Period 3: 26th November 2021 to December 2021; Period 4: January 2022 to 28th January 2022 and 7th March 2022 for EHR and population cohorts, respectively. Patients represented within the EHR cohort (A-C) are excluded from the population cohort (D). *P*-values were calculated using log-rank test for differences across the four subgroups.


A
1
2
3
4
Probability of admission
1.00
0.75
0.50
0.25
0.00
p = 0.025
0
5
10
15
20
25
30
Time (days from +PCR)
Number at risk
59 22 20 20 18 18 18
40 8 7 6 6 6 6
32 18 16 15 15 14 13
22 12 10 10 9 8 7
B
1
2
3
4
Probability of ICU
1.00
0.75
0.50
0.25
0.00
p = 0.18
0
5
10
15
20
25
30
Time (days from +PCR)
Number at risk
59 55 51 47 45 45 45
40 32 29 29 29 29 29
32 32 30 30 30 29 28
22 21 18 18 17 15 13
C
1
2
3
4
Probability of survival
1.00
0.75
0.50
0.25
0.00
p = 0.71
0
5
10
15
20
25
30
Time (days from +PCR)
Number at risk
59 58 58 54 52 51 50
40 37 33 33 33 33 33
32 32 31 31 31 30 29
22 21 18 18 17 15 13
D
1
2
3
4
Probability of survival
1.00
0.75
0.50
0.25
0.00
p = 0.0021
0
5
10
15
20
25
30
Time (days from +PCR)
Number at risk
24 24 24 24 24 24 24
66 66 66 65 65 63 62
73 73 72 72 71 70 69
477 477 475 474 474 473 473
E
1
2
3
4
Probability of survival
1.00
0.75
0.50
0.25
0.00
p < 0.0001
0
5
10
15
20
25
30
Time (days from +PCR)
Number at risk
83 82 82 78 76 75 74
106 103 99 98 98 96 95
105 105 103 103 102 100 98
499 498 493 492 491 488 486

		Period 1		Period 2		Period 3		Period 4			
Covariate		EHR (n= 59)	Population (n=24)	EHR (n=40)	Population (n=66)	EHR (n=32)	Population (n=73)	EHR (n=22)	Population (n=477)	Total (n=793)	*P*-value
Age at PCR	median [iqr]	71 [64.5, 80.5]	70.5 [54.2, 74.5]	77 [68.2, 82.0]	70 [62, 78]	74.5 [69.8, 83.0]	70 [63, 77]	76 [72.0, 80.5]	72 [64, 77]	72 [64, 78]	.0052
Sex	Female	27 (45.8)	7 (29.2)	17 (42.5)	24 (36.4)	12 (37.5)	29 (39.7)	9 (40.9)	181 (37.9)	306 (38.6)	
	Male	32 (54.2)	17 (70.8)	23 (57.5)	42 (63.6)	20 (62.5)	44 (60.3)	13 (59.1)	296 (62.1)	487 (61.4)	.91
CLL diagnosis	median [iqr]	2017 [2012, 2019]	2015 [2011.8, 2016]	2015 [2010, 2018]	2015 [2013, 2016]	2016 [2014, 2018]	2015 [2013, 2017]	2017 [2014, 2018]	2015 [2012, 2017]	2015 [2012, 2017]	.024
	missing	1	0	0	0	1	0	1	0	3	
Binet stage	A	34 (87.2)	20 (83.3)	22 (75.9)	57 (86.4)	21 (95.5)	69 (94.5)	14 (73.7)	402 (84.3)	639 (85.3)	
	B	3 (7.7)	2 (8.3)	6 (20.7)	7 (10.6)	1 (4.5)	4 (5.5)	3 (15.8)	65 (13.6)	91 (12.1)	
	C	2 (5.1)	2 (8.3)	1 (3.4)	2 (3.0)	0 (0.0)	0 (0.0)	2 (10.5)	10 (2.1)	19 (2.5)	.097
	missing	20	0	11	0	10	0	3	0	44	
IGHV status	Unmutated	8 (28.6)	6 (33.3)	9 (39.1)	18 (33.3)	6 (40.0)	19 (33.9)	3 (20.0)	105 (27.0)	174 (29.1)	
	Mutated	20 (71.4)	12 (66.7)	14 (60.9)	36 (66.7)	9 (60.0)	37 (66.1)	12 (80.0)	284 (73.0)	424 (70.9)	.70
	missing	31	6	17	12	17	17	7	88	195	
FISH status	Del13q	18 (64.3)	11 (64.7)	10 (43.5)	28 (54.9)	9 (50.0)	34 (61.8)	7 (46.7)	221 (61.6)	338 (59.7)	
	Normal	3 (10.7)	1 (5.9)	4 (17.4)	9 (17.6)	0 (0.0)	9 (16.4)	1 (6.7)	44 (12.3)	71 (12.5)	
	Tri12	4 (14.3)	3 (17.6)	3 (13.0)	6 (11.8)	5 (27.8)	9 (16.4)	3 (20.0)	53 (14.8)	86 (15.2)	
	Del11q	1 (3.6)	1 (5.9)	3 (13.0)	5 (9.8)	2 (11.1)	3 (5.5)	3 (20.0)	24 (6.7)	42 (7.4)	
	Del17p	2 (7.1)	1 (5.9)	3 (13.0)	3 (5.9)	2 (11.1)	0 (0.0)	1 (6.7)	17 (4.7)	29 (5.1)	.68
	missing	31	7	17	15	14	18	7	118	227	
Admission	Yes	41 (69.5)	NA	33 (82.5)	NA	19 (59.4)	NA	12 (54.5)	NA	105 (68.6)	
	No	18 (30.5)	NA	7 (17.5)	NA	13 (40.6)	NA	10 (45.5)	NA	48 (31.4)	.075
	missing	0	24	0	66	0	73	0	477	640	
ICU	Yes	7 (11.9)	NA	5 (12.5)	NA	1 (3.1)	NA	0 (0.0)	NA	13 (8.5)	
	No	52 (88.1)	NA	35 (87.5)	NA	31 (96.9)	NA	22 (100.0)	NA	140 (91.5)	.26
	missing	0	24	0	66	0	73	0	477	640	
Died	Yes	10 (16.9)	0 (0.0)	7 (17.5)	4 (6.1)	3 (9.4)	4 (5.5)	5 (22.7)	4 (0.8)	37 (4.7)	
	No	49 (83.1)	24 (100.0)	33 (82.5)	62 (93.9)	29 (90.6)	69 (94.5)	17 (77.3)	473 (99.2)	756 (95.3)	< .0001
Dexa-methasone	Yes	11 (18.6)	NA	16 (40.0)	NA	9 (28.1)	NA	4 (18.2)	NA	40 (26.1)	
	No	48 (81.4)	NA	24 (60.0)	NA	23 (71.9)	NA	18 (81.8)	NA	113 (73.9)	.090
	missing	0	24	0	66	0	73	0	477	640	

Remdesivir	Yes	12 (20.3)	NA	18 (45.0)	NA	8 (25.0)	NA	3 (13.6)	NA	41 (26.8)	
	No	47 (79.7)	NA	22 (55.0)	NA	24 (75.0)	NA	19 (86.4)	NA	112 (73.2)	.019
	missing	0	24	0	66	0	73	0	477	640	
mAb	Yes	0 (0.0)	NA	10 (25.0)	NA	12 (37.5)	NA	8 (36.4)	NA	30 (19.6)	
	No	59 (100.0)	NA	30 (75.0)	NA	20 (62.5)	NA	14 (63.6)	NA	123 (80.4)	< .0001
	missing	0	24	0	66	0	73	0	477	640	